

ISOTOPIC VARIATIONS IN ATMOSPHERIC MOISTURE IN THE GREAT PLAINS REGION

Madhav V. Machavaram, Mark E. Conrad, and Norman L. Miller

Contact: Madhav V. Machavaram, 510/486-5026, mvmachavaram@lbl.gov

RESEARCH OBJECTIVES

The stable isotopic composition of atmospheric water vapor at a given region is determined by its source and subsequent admixture and condensation processes. The most dynamic changes in the water cycle occur in the atmospheric part of the cycle. Thus, the variation in the stable isotope ratios of atmospheric vapor provides critical information about the locally evapo-transpired moisture. In our work, we analyzed atmospheric vapor samples to improve predictability, in part by integrating stable isotope variations into climatological models.

APPROACH

To understand the response of regional hydrology to climatic variations, it is important to quantify the influence of local moisture on precipitation. The deuterium excess (δ -excess)—a measure of the abundance of deuterium (δ D) over 18-oxygen ($\delta^{18}\text{O}$)—is a valuable tool for estimating the contribution of secondary moisture sources to atmospheric moisture. The d -excess in the atmospheric vapors is determined primarily at the oceanic source and altered by admixture of secondary moisture derived through evapo-transpiration. Thus, by measuring the d -excess in atmospheric vapors, we can estimate the influence of land-derived moisture.

ACCOMPLISHMENTS (DATA DISCUSSION)

Samples of atmospheric vapor between the earth surface and 3,500 m altitude were cryogenically collected during a flight operation. The stable isotope data for the vapor samples are presented in Figure 1. The samples that were collected below 700 m exhibited much smaller isotopic variation than those from above. The top of the Atmospheric Boundary Layer (ABL) was determined to be at 1,000 m from the surface during the sampling time. The height of the ABL marks the altitude above which the turbulence of the lower troposphere is negligible. Thus, the sample collected at 3,660 m height could

be considered as the atmospheric moisture originating from the Gulf of Mexico.

Assuming that the samples above and below the ABL represent two end members on a linear mixing line, we performed a mixing calculation using the d -excess values, which indicated that approximately 75% of the moisture within the ABL is derived from local sources through evapo-transpiration.

Although the contribution of secondary moisture may change diurnally and seasonally, the overall effect of locally derived moisture on precipitation is believed to remain significant over time.

SIGNIFICANCE OF FINDINGS

Understanding the influence of locally derived moisture on the water cycle is valuable for improving climatological models. When monitored over longer time scales, such information is extremely useful in documenting the hydrological changes of a region through man-made causes, such as agriculture and urbanization.

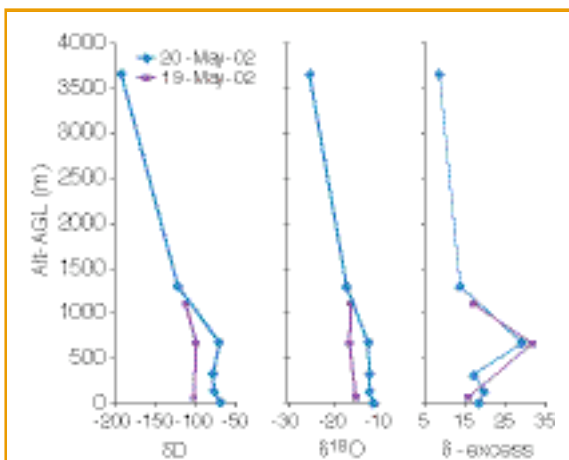


Figure 1. Isotopic variation in the atmospheric vapor samples at various altitudes

RELATED PUBLICATIONS

Machavaram, M.V., M.E. Conrad, and N.L. Miller, The deuterium excess in precipitation and atmospheric moisture in the southern Great Plains region of USA. AGU Conference, San Francisco, California, December 6–10, 2002.

Machavaram, M.V., D.O. Whittemore, M.E. Conrad, and N.L. Miller, Precipitation induced stream flow: An event based study in a small stream from the Great Plains region of the USA, 2003 (to be submitted to Journal of Hydrology).

ACKNOWLEDGMENTS

This work was supported by the Director, Office of Science, Office of Basic Energy Sciences, Division of Chemical Sciences, Geosciences, and Biosciences, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

